

Description

Method and System For Providing Diagnostics for a Work Machines

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Technical Field

This invention relates generally to providing diagnostics for work machines and work particular to a computer based method and system for providing case based diagnostics for work machines.

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Background Art

Case based reasoning has been applied to various diagnostics and "help-desk" tools. A case contains a list of symptoms, a set of case bases and a set of action items describing an appropriate repair or test. A case base contains questions and paths to possible repairs/tests, i.e., action items. The case base includes answers to the questions which are designed to lead the user to a diagnosis or an action item to solve the problem.

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However, for some work machines or systems there are in existence other tools and systems containing information related to the machine, e.g., repair and technical information. In the field, there may be other systems directly connected to the machine or system that contain information which would be helpful to the diagnostic system to have access to assist in the process of diagnosing or providing repair or test solutions.

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The present invention is directed to overcome one or more of the problems as set forth above.

Disclosure of the Invention

In one aspect of the present invention, a computer based method for providing case base
5 diagnostics for a work machine, is provided. The case bases include diagnostic information and processes related to the work machine. The method includes the steps of receiving from an user, a description of an initial problem related to the work machine and
10 displaying at least one question, as a function of the initial problem. The method also includes the steps of displaying a first set of recommended actions, as a function of the initial problem, and receiving an answer from the user to the at least one question.
15 The method further includes the step of displaying a second set of recommended actions as a function of the initial problem and the answer to the at least one question, wherein the second set of recommended actions is a subset of the first set of recommended
20 actions.

In another aspect of the present invention, a computer based system for providing case base diagnostics for a work machine is provided. The case bases include diagnostic information and processes
25 related to the work machine. The system includes an external source containing service information related to the work machine and a diagnostic advisor tool. The diagnostic advisor tool is adapted to interact with a user, receive information from the user and
30 responsively display at least one recommended action, and provide a link to relevant information within the external source.

Brief Description of the Drawings

Fig. 1 is a block diagram of a computer based system for providing case base diagnostics for a work machine, according to an embodiment of the present invention;

Fig. 2 is a flow diagram of a method for providing case base diagnostics for a work machine, according to an embodiment of the present invention;

Fig. 3 is a diagrammatic illustration of a Diagnostic Advisor Window of the computer based system and method of Figs. 1 and 2;

Fig. 4 is a diagrammatic illustration of a button bar of the computer based system and method of Figs. 1 and 2;

Fig. 5 is a diagrammatic illustration of a Pop-Up Menu of the computer based system and method of Figs. 1 and 2;

Fig. 6 is a diagrammatic illustration of a Pop-Up Menu of the computer based system and method of Figs. 1 and 2;

Fig. 7 is a diagrammatic illustration of a Pop-Up Menu of the computer based system and method of Figs. 1 and 2;

Fig. 8 is a diagrammatic illustration of a Pop-Up Menu of the computer based system and method of Figs. 1 and 2;

Fig. 9 is a diagrammatic illustration of an Action Pop-Up Menu of the computer based system and method of Figs. 1 and 2;

Fig. 10A is a diagrammatic illustration of a Confidence Bar of the computer based system and method

of Figs. 1 and 2;

Fig. 10B is a second diagrammatic illustration of the Confidence Bar of Fig. 10A;

Fig. 11 is a diagrammatic illustration of a
5 Question Detail Window of the computer based system
and method of Figs. 1 and 2;

Fig. 12A is a diagrammatic illustration of
an Action Detail Window of the computer based system
and method of Figs. 1 and 2;

10 Fig. 12B is a second diagrammatic
illustration of the Action Detail Window of Fig. 12A;

Fig. 13 is a diagrammatic illustration of an
Alert Dialog;

Fig. 14 is a diagrammatic illustration of a
15 Diagnostics Code Procedures List and Test Steps List
of the computer based system and method of Figs. 1 and
2;

Fig. 15 is a diagrammatic illustration of a
Functional Test List and a Functional Test Steps List
20 of the computer based system and method of Figs. 1 and
2;

Fig. 16 is a diagrammatic illustration of a
Test Procedure Panel of the computer based system and
method of Figs. 1 and 2;

25 Fig. 17 is a diagrammatic illustration of a
Report Panel of the computer based system and method
of Figs. 1 and 2;

Fig. 18 is a diagrammatic illustration of a
Create New Report Dialog of the computer based system
30 and method of Figs. 1 and 2;

Fig. 19 is a diagrammatic illustration of a
Feedback Dialog of the computer based system and

method of Figs. 1 and 2; and

Fig. 20 is a diagrammatic illustration of an Active/Logged Codes Panel of the computer based system and method of Figs. 1 and 2.

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Best Mode For Carrying Out The Invention

With reference to the drawings and in operation, the present invention provides a computer based method and system and a computer program for providing case based diagnostics for a work machine. The work machine can be any sort of machine such as an earthmoving machine, construction machine, transportation machine, engine, computer, air conditioner, etc. ... This list is exemplary only and not intended to be exclusive.

Generally, a case contains diagnostic information and processes related to a work machine. A case contains a list of symptoms, a set of case bases, and a set of action items describing an appropriate repair or test. A case base contains questions and paths to possible repairs/tests.

Preferably, the present invention is implemented in software for execution on a computer.

With reference to Fig. 1, a computer based system 100 for providing case based diagnostic for a work machine 102 according to the present invention will now be discussed.

An external source 104 provides service information related to the work machine 102.

Preferably, the external source 104 includes an Electronic Technician (ET) module 106, a Data View module 108, a service information system 110, and an

_____ (EPE). The service information system 110 includes service information related to the work machine 102. Preferably, the service information system 112 includes system functional tests and
5 diagnostic code procedures.

The computer based system 100 includes a diagnostic advisor tool 114. The computer based system 100 further includes a tool report module 116 for generating reports.

10 In the preferred embodiment, the diagnostic advisor tool 114 is linked to the external source 104 through a common software module called Service Technician Workbook (STW) 116.

The computer based system 100 is utilized by
15 an user 118. The user 118 utilizes the diagnostic advisor tool 114 to provide diagnostics to the work machine 102. As discussed below, links to sources of information within the external source 104 are provided within the diagnostic advisor tool 114. The
20 linked information may includes technical information, system functional tests and/or diagnostic code procedures. A system functional test is defined as a procedure for troubleshooting systems, circuits or specific components of the work machine 102. Most of
25 these tests are developed to determine if the system, circuit or component is functioning correctly, and if not, to isolate the cause of the problem. A diagnostic code procedure is defined as a trouble shooting procedure for determining the cause of a
30 diagnostic code returned by an electronic control module (ECM) over a data link identifying past or present logged problems with the ECM (not shown).

Electronic Technician or ET links may also be embedded into question and actions. ET links will be attached to questions to aid the user 118 in answering the questions. For instance, the question
5 may read "What is the oil temperature?". The user 118 could then click on the ET attachment that will automatically read the oil temperature from the machine. Comparatively, an action may state "Check for any logged or active codes on the machine."

10 The computer based system 100 is embodied in computer program product i.e., software. The computer program product comprises a computer usable storage medium having computer readable program code means embodied in the medium.

15 With reference to Fig. 2, a computer based method 200 for providing case base diagnostics for a work machine 102, is provided. The case bases are comprised of diagnostic information and processes related to the work machine 102. In a first step 202,
20 a description of an initial problem related to the work machine 102 is received from the user 118. In a second step 204 at least one question is displayed as a function of the first question. In a third step 206, a first set of recommended actions is displayed
25 as a function of the initial problem. An answer to the at least one question is provided by the user 118 in a fourth step 208. A second set of recommended actions is displayed as a function of the initial problem and the answer provided by the user 118 in a
30 fifth step. The second set of recommended actions is a subset of the first set of recommended actions.

With reference to Figs. 3-17, the present

invention provides a graphical user interface 300 for use by the user 118 to interface with the system 100.

With particular reference to Fig. 3, the graphical user interface 300 includes a Diagnostic Advisor Window 302. The Diagnostic Advisor Window 302 includes a Menu Bar 304, a Toolbar 306, and a Tabbed Panel 308. The graphical user interface 300 further includes a Diagnose Problem Tab 310, a Diagnostic Code Tab 312, a Functional Tests Tab 314, and a Product ID Drop Down List 316.

The Tabbed Panel 306 includes an Information Panel 318. The contents of the Information Panel 318 are dependent upon an active or selected Tab 310, 312, 314.

With reference to Fig. 4, the tool bar 304 preferably includes a Feedback Button 402, a Report Button 404, a Bookmark Button 406, a Read Codes Button 408, an exit button 410 and a Help Button 412.

Returning to Fig. 3, when the Diagnostic Problem Tab 310 is selected or actuated, the Information Panel 318 includes a Diagnostic Panel 319. The Diagnostics Panel 319 includes a Questions Section 320 and a Recommended Action Section 322. The Questions Section 320 includes a Question Column 324 and an Answer Column 326. As shown, a series of questions is listed in the Questions Section 320. A corresponding entry (to each question) in the Answer Column 326 lists the answers to the respective question.

The Recommended Action Section 322 includes a Confidence Column 328, an Action Column 330, and a Status Column 332.

The Diagnostic Panel 319 further includes a Complaint Section 334. The Complaint Section 334 includes a Customer Complaint Text Field 336, a Find Button 338 and a Clear Button 340. The Clear Button
5 340 clears the Customer Complaint Text Field 336.

In order to begin the diagnostic process, the user 118 enters the initial problem into the Customer Complaint Text Field 336 and actuates the Find Button 338. A list of relevant questions are
10 displayed in the Question Column 324 of the Question Section 320. The answers given by the user 118 or default answers are displayed in the answers column 326.

A list of possible actions to resolve the
15 complaint are listed in the Action Column 330 of the Action Section 322. The status of the relevant action, e.g., performed or not performed are listed in the Status Column 332.

As explained below, the user 118 answers one
20 or more of the questions presented. As the questions are answered, the Action Section 322 is updated, e.g., actions no longer valid are removed. Additionally, the confidence levels are updated. Preferably, the Confidence Column 328 includes at least one confidence
25 gauge illustrating the relative confidence of the action.

In the preferred embodiment, the user 118 answers questions by invoking a pop-menu related to the question to be answered. Typically, pop-up menus
30 are invoked by clicking on the desired question with the right mouse button of a two button mouse. The contents of the pop-menu will be dependent upon the

desired question.

Some exemplary pop-up menus are shown in Figs. 5-8.

With specific reference to Fig. 5, a pop-up menu 502 with several choices is illustrated. Unavailable choices are "grayed" out. In this instance, the proper answer to the question is a simple "Yes" 504 or "No" 506. To answer the question, the user 118 simply selects the proper answer. The Pop-Up Menu 502 disappears and the selected answer is input to the system 100.

The Pop-up Menu 502 provides additional options as well. For example, the user 118 can get detailed information related to a question (option 508). If a previous answer was erroneous or has changed, the user 118 can "unanswer" the question (option 510). Additionally, the user 118 can choose to run the Service Information System 110 (option 512) or to view linked service information 514. The Pop-up Menu 502 may also include a link to alert, warning, or caution information 514.

With reference to Fig. 6, if the question requires more than a yes or no answer, the Pop-up Menu 602 includes all of the possible answers to the question.

With reference to Fig. 7, a link to the Electronic Technician Module 704 on a Pop-Up Menu 702 may also be provided.

With reference to Fig. 8, if the user 118 wants to see service information related to the relevant question, the user 118 highlights the Service Information Option 804 on the Pop-Up Menu 802. A list

806 of the available service information documents appears. The User 118 can select the desired documents from the list 806.

With reference to Fig. 9, the user 118 indicates that a recommended action has been performed through a Performed Option 904 on an Action Pop-Up Menu 902. The Action Pop-Up Menu 902 may also include links to external sources, e.g., a Service Information System link 906 or a link to available service information documents 908.

With reference to Figs. 10A and 10B, a confidence bar 1002 is used to give the user 118 a visual cue as to how likely an action is to correct a problem. The confidence bar 1002 is displayed in the Confidence Column 328 in the same line as the relevant action. Preferably, the confidence bar is in the form of a bar graph. Additionally, the bar graph is in a first color, such as black, if the stated confidence is below a predetermined level and a second color, such as green, if the stated confidence is above a predetermined level.

With reference to Figs. 11, if the user 118 selects the Detail Option 508 from the Pop-Up Menu 502, a Question Detail Window 1102 is displayed. The Question Detail Window 1102 includes a Question Section 1104, a Service Information Section 1106, an Answer Section 1108, and a Measurement Section 1110.

The Question Section 1104 includes a Question Text Field 1112 which contains the question to be answered by the user 118. The Service Information Section 1106 includes links to specified service information documents. These links are

preferably hyperlinks. Actuation of the hyperlinks opens the relevant document. The Answer Section 1108 lists all available answers to the question. The user 118 simply selects the appropriate answer.

5 The Measurement Section 1110 includes a Start Button 1114, a Stop Button 1116, and a List 1118. The Measurement Section 1110 provides a link to data available from the work machine 102 via the Electronic Technician Module 106 through the Service
10 Technician Workbench 116. A list of all available measurement sources from the work machine 102 is shown in the List 1118. The user 118 selects the desired measurement and actuates the Start Button 1114 to retrieve the data.

15 The Question Detail Window 1102 includes an OK Button 1120, a Cancel Button 1122, a Next Button 1124 and a Help Button 1126. Actuation of the OK Button 1120 dismisses the Question Detail Window 1102 while saving any information stored in the Question
20 Detail Window 1102.

 Actuation of the Cancel Button 1122, dismisses the Question Detail Window 1102 without saving any data.

 Actuation of the Next Button 1124 brings up
25 the next question, if any, into the Question Detail Window 1102.

 With reference to Figs. 12A and 12B, the user 118 can double click on an Action to display an Action Detail Window 1202. The Action Detail Window
30 1202 includes an Action Text Box 1204, a Service Information Text Box 1206, a Confidence Gauge 1208, and an Action Performed Check Box 1210.

The Action Text Box 1204 includes a description of the recommended action.

The Service Information Text Box 1206 includes detailed information regarding the recommended action item, as well as links to external sources for additional information.

The Confidence Gauge 1208 gives the user 118 a visual indication of the likelihood that the current recommended action will solve the problem.

The user 118 actuates the Action Performed Check Box 1208 to indicate that the present action has been performed.

The Action Detail Screen 1202 further includes an OK Button 1212, a Cancel Button 1214, a Next Button 1216, and a Help Button 1218. Actuation of the OK Button 1212 dismisses the Action Detail Window 1102 while saving any information stored in the Action Detail Window 1102.

Actuation of the Cancel Button 1214, dismisses the Question Detail Window 1102 without saving any data.

Actuation of the Next Button 1216 brings up the next recommended action, if any, into the Answer Detail Window 1202.

With reference to Fig. 12B, an Action Detail Screen 1202 is shown including an Measurements Section 1220. The Measurement Section 1220 includes a Start Button 1222, a Stop Button 1224, and a List 1226. The Measurement Section 1220 provides a link to data available from the work machine 102 via the Electronic Technician Module 106 through the Service Technician Workbench 116. A list of all available

measurement sources from the work machine 102 is shown in the List 1226. The user 118 selects the desired measurement and actuates the Start Button 1114 to retrieve the data.

5 With reference to Fig. 13, an Alert Dialog 1302 is displayed prior to the display of the Question Detail Window 1102 or the Action Detail Window 1202. The Alert Dialog 1302 includes an OK Button 1304 which must be actuated to dismiss of the Alert Dialog 1302.

10 Preferably, the Diagnostic Advisor Tool 114 has four levels of alerts: Dangers; Warnings; Cautions; and Notices.

 With reference to Fig. 14, when the Diagnostic Code Tab 312 is selected or actuated, the Information
15 Panel 318 includes a Diagnostic Code Panel 1400. The Diagnostic Code Panel 1400 includes a Diagnostic Code Procedures List 1402 and a Test Steps List 1404.

 The Diagnostic Code Procedures List 1402 displays all valid codes and test names for the
20 current serial number/prefix selected in the Product ID Drop Down List 316. Preferably, the Diagnostic Code Procedures List 1402 includes a Code Column 1406, a Title Column 1408, a Occurrences Column 1410, a Status Column 1412, and a Results Column 1414. The
25 Code Column 1406 and the Title Column 1408 contain identifying information. The Occurrences Column 1410 and the Status Column 1412 lists the number of occurrences for the respective code and the current status, respectively. In the preferred embodiment,
30 this information is received from the Electronic Technician Module 106.

 As shown, the diagnostic codes displayed in the

Diagnostic Code Procedures List 1402 are grouped in an expandable tree format. An OK Button 1416 starts the selected test step.

The Test Steps List 1404 displays the tests
5 steps for the currently selected code in the Diagnostic Code Procedures List 1402. After the test is over, the result is displayed on the Results Column 1414.

With reference to Fig. 15, when the Functional
10 Tests Tab 314 is selected or actuated, the Diagnostic Panel 318 includes a Functional Test Panel 1500. The Functional Test 1500 Panel includes a Functional Test List 1502 and a Functional Test Steps List 1504.

The Functional Test List 1502 includes a Test
15 Name Column 1506 and a Results Column 1508. The Test Name Column 1506 includes a list of all functional tests available for the current serial number/prefix selected in the Product ID Drop Down List 316. Preferably, the functional tests are grouped in an
20 expandable tree format as shown.

The test steps for the currently selected functional test in the Functional Test List 1502 are displayed in the Functional Test Steps List 1504. An OK Button 1510 starts the selected step in the
25 Function Test Steps List 1504.

With reference to Fig. 16, when either OK
Button 1416, 1510 is actuated the Diagnostic Panel 318 includes a Test Procedure Panel 1602. Fig. 16 shows an exemplary step in a functional test, however, the
30 Test Procedure Panel 1602 for a diagnostic step operates in a similar manner. The Test Procedure Panel 1602 includes a Test Step Panel 1604, a Graphic Viewer

Panel 1606 and a Results Panel 1608. The Test Step Panel 1604 displays detailed test step information. The following may be included in the Test Step Panel 1604:

- 5 • Title
- Instructions
- Links to Service Information System 110
- Links to graphics associated with the test
- Links to alerts (danger/warnings/caution/notice)
- 10 • Links to a detail section associated with the test.

Graphics, alerts and detailed information are displayed in the Graphics Viewer Panel 1606.

- The Results Panel 1608 includes an optional
- 15 Results Text Field 1610 and a series of Results Buttons 1612. The Results Text Field 1610 includes a description of the results. The Results Buttons 1612 are used by the user 118 to select the appropriate results from the test step. The number and
 - 20 description of each button 1612 is dependent upon the test step and the possible results from the test step. For example as shown in Fig. 16, the coolant temperature sensor function test step has an OK Button 1612A, a NOT OK Button 1612B, and an INVALID DATA
 - 25 Button 1612C.

A Previous Button 1614 returns to a previous step (if any) and a Cancel Button 1616 dismisses the Test Procedure Panel 1602.

- With reference to Fig. 17, the Tabbed Panel
- 30 308 also includes a Report Tab 1702. Selection of the Report Tab 1702 by the user 118, results in a Report

Panel 1704 being displayed. The Report Panel 1704 includes detailed information about the current diagnostic session. The Report Panel 1704 includes a Print Button 1706, a Save Button 1708, and a Refresh Button 1710. Actuation of the Print Button 1706 opens up a Print Dialog (not shown) for printing the current report. Actuation of the Save Button 1708 opens a Save Dialog (not shown) for saving the report. And actuation of the Refresh Button 1810 refreshes the report with any new data.

With reference to Fig. 18, new reports are created by first selecting a menu item (not shown) from the Menu Bar 304 which opens up a Create New Report Dialog 1802.

The user 118 fills out the information requested on the Create New Report Dialog 1802 and actuates a Create Report Button 1804.

With reference to Fig. 19, a Feedback Dialog 1902 is displayed upon actuation of the Feedback Button 402. The Feedback Dialog allows the user 118 to provide feedback concerning the Diagnostic Tool 114. The user 118 can offer corrections or suggestions for improving software functionality in the provided elements. The user's feedback may then be used in later releases of the Diagnostic Tool 114.

With reference to Fig. 20, the Tabbed Panel 308 also includes an Active/Logged Codes Tab 2002. Selection of the Active/Logged Codes Tab 2002 by the user 118, results in a Active/Logged Codes Panel 2004 being displayed. The Active/Logged Codes Panel 2004 is initially invoked when the user 118 selects a Read Codes Menu Item (not shown) from the Menu Bar 304 or

actuates the Read Codes Button 408. The Active/Logged
Codes Panel 2002 is updated whenever the Electronic
Technician Module 106 returns diagnostic codes. All
new codes have an asterisk at the front and are listed
5 first.

Of course, various modifications of this
invention would come within the scope of the
invention.

10 Industrial Applicability

In use, the Diagnostic Tool Advisor 114 is
utilized by a field technician or user 118. The
Diagnostic Tool Advisor 114 is preferably implemented
on a personal or laptop computer (not shown).

15 In the preferred embodiment, the Diagnostic
Tool Advisor 114 is implemented as part of an Service
Technician Workbench (STW) 116 which implements other
related software as well as the Diagnostic Advisor
Tool 114. Through the STW 116, the Diagnostic Advisor
20 Tool 114 is coupled to the Electronic Technician
Module 106. The Electronic Technician Module 106 is
coupled to the work machine. Specifically, the
Electronic Technician Module 106 is coupled to the
machine to retrieve information from the work machine
25 106, e.g., sensor data and diagnostic codes.

The user 119 utilizes the Diagnostic Advisor
Tool 114 to perform a diagnosis of the work machine by
inputting the general or initial problem and then
answering a series of questions presented by the
30 Diagnostic Advisor Tool 114.

The Diagnostic Advisor Tool 114 also
presents the user 118 with one or more diagnostic or

functional tests to perform in order to assist in the diagnosis.

Other aspects, objects and advantages of this invention can be obtained from a study of the
5 drawings, the disclosure and the appended claims.

FIG. 1 is a perspective view of the device in a first position.
FIG. 2 is a perspective view of the device in a second position.
FIG. 3 is a perspective view of the device in a third position.
FIG. 4 is a perspective view of the device in a fourth position.
FIG. 5 is a perspective view of the device in a fifth position.
FIG. 6 is a perspective view of the device in a sixth position.
FIG. 7 is a perspective view of the device in a seventh position.
FIG. 8 is a perspective view of the device in an eighth position.
FIG. 9 is a perspective view of the device in a ninth position.
FIG. 10 is a perspective view of the device in a tenth position.
FIG. 11 is a perspective view of the device in an eleventh position.
FIG. 12 is a perspective view of the device in a twelfth position.
FIG. 13 is a perspective view of the device in a thirteenth position.
FIG. 14 is a perspective view of the device in a fourteenth position.
FIG. 15 is a perspective view of the device in a fifteenth position.
FIG. 16 is a perspective view of the device in a sixteenth position.
FIG. 17 is a perspective view of the device in a seventeenth position.
FIG. 18 is a perspective view of the device in an eighteenth position.
FIG. 19 is a perspective view of the device in a nineteenth position.
FIG. 20 is a perspective view of the device in a twentieth position.
FIG. 21 is a perspective view of the device in a twenty-first position.
FIG. 22 is a perspective view of the device in a twenty-second position.
FIG. 23 is a perspective view of the device in a twenty-third position.
FIG. 24 is a perspective view of the device in a twenty-fourth position.
FIG. 25 is a perspective view of the device in a twenty-fifth position.
FIG. 26 is a perspective view of the device in a twenty-sixth position.
FIG. 27 is a perspective view of the device in a twenty-seventh position.
FIG. 28 is a perspective view of the device in a twenty-eighth position.
FIG. 29 is a perspective view of the device in a twenty-ninth position.
FIG. 30 is a perspective view of the device in a thirtieth position.
FIG. 31 is a perspective view of the device in a thirty-first position.
FIG. 32 is a perspective view of the device in a thirty-second position.
FIG. 33 is a perspective view of the device in a thirty-third position.
FIG. 34 is a perspective view of the device in a thirty-fourth position.
FIG. 35 is a perspective view of the device in a thirty-fifth position.
FIG. 36 is a perspective view of the device in a thirty-sixth position.
FIG. 37 is a perspective view of the device in a thirty-seventh position.
FIG. 38 is a perspective view of the device in a thirty-eighth position.
FIG. 39 is a perspective view of the device in a thirty-ninth position.
FIG. 40 is a perspective view of the device in a fortieth position.
FIG. 41 is a perspective view of the device in a forty-first position.
FIG. 42 is a perspective view of the device in a forty-second position.
FIG. 43 is a perspective view of the device in a forty-third position.
FIG. 44 is a perspective view of the device in a forty-fourth position.
FIG. 45 is a perspective view of the device in a forty-fifth position.
FIG. 46 is a perspective view of the device in a forty-sixth position.
FIG. 47 is a perspective view of the device in a forty-seventh position.
FIG. 48 is a perspective view of the device in a forty-eighth position.
FIG. 49 is a perspective view of the device in a forty-ninth position.
FIG. 50 is a perspective view of the device in a fiftieth position.
FIG. 51 is a perspective view of the device in a fifty-first position.
FIG. 52 is a perspective view of the device in a fifty-second position.
FIG. 53 is a perspective view of the device in a fifty-third position.
FIG. 54 is a perspective view of the device in a fifty-fourth position.
FIG. 55 is a perspective view of the device in a fifty-fifth position.
FIG. 56 is a perspective view of the device in a fifty-sixth position.
FIG. 57 is a perspective view of the device in a fifty-seventh position.
FIG. 58 is a perspective view of the device in a fifty-eighth position.
FIG. 59 is a perspective view of the device in a fifty-ninth position.
FIG. 60 is a perspective view of the device in a sixtieth position.
FIG. 61 is a perspective view of the device in a sixty-first position.
FIG. 62 is a perspective view of the device in a sixty-second position.
FIG. 63 is a perspective view of the device in a sixty-third position.
FIG. 64 is a perspective view of the device in a sixty-fourth position.
FIG. 65 is a perspective view of the device in a sixty-fifth position.
FIG. 66 is a perspective view of the device in a sixty-sixth position.
FIG. 67 is a perspective view of the device in a sixty-seventh position.
FIG. 68 is a perspective view of the device in a sixty-eighth position.
FIG. 69 is a perspective view of the device in a sixty-ninth position.
FIG. 70 is a perspective view of the device in a seventieth position.
FIG. 71 is a perspective view of the device in a seventy-first position.
FIG. 72 is a perspective view of the device in a seventy-second position.
FIG. 73 is a perspective view of the device in a seventy-third position.
FIG. 74 is a perspective view of the device in a seventy-fourth position.
FIG. 75 is a perspective view of the device in a seventy-fifth position.
FIG. 76 is a perspective view of the device in a seventy-sixth position.
FIG. 77 is a perspective view of the device in a seventy-seventh position.
FIG. 78 is a perspective view of the device in a seventy-eighth position.
FIG. 79 is a perspective view of the device in a seventy-ninth position.
FIG. 80 is a perspective view of the device in an eightieth position.
FIG. 81 is a perspective view of the device in an eighty-first position.
FIG. 82 is a perspective view of the device in an eighty-second position.
FIG. 83 is a perspective view of the device in an eighty-third position.
FIG. 84 is a perspective view of the device in an eighty-fourth position.
FIG. 85 is a perspective view of the device in an eighty-fifth position.
FIG. 86 is a perspective view of the device in an eighty-sixth position.
FIG. 87 is a perspective view of the device in an eighty-seventh position.
FIG. 88 is a perspective view of the device in an eighty-eighth position.
FIG. 89 is a perspective view of the device in an eighty-ninth position.
FIG. 90 is a perspective view of the device in a ninetieth position.
FIG. 91 is a perspective view of the device in a ninety-first position.
FIG. 92 is a perspective view of the device in a ninety-second position.
FIG. 93 is a perspective view of the device in a ninety-third position.
FIG. 94 is a perspective view of the device in a ninety-fourth position.
FIG. 95 is a perspective view of the device in a ninety-fifth position.
FIG. 96 is a perspective view of the device in a ninety-sixth position.
FIG. 97 is a perspective view of the device in a ninety-seventh position.
FIG. 98 is a perspective view of the device in a ninety-eighth position.
FIG. 99 is a perspective view of the device in a ninety-ninth position.
FIG. 100 is a perspective view of the device in a hundredth position.